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13. ABSTRACT *(Maximum 200 words)*

A 550 kip testing press was acquired by Texas A&M University during the period from April of 1998 through June of 1999. The primary function of the press is to aid in the equal channel angular extrusion (ECAE) process research currently underway in the Department of Mechanical Engineering. Secondary functions include materials testing, education in material deformation, and fabrication forming. The acquisition of the press has enhanced the research efforts in ECAE processing by providing a dedicated, convinent, efficient, and safe facility for a wide range of related experiments. The research related educational benefits are being recognized via several graduate student research projects. A plan for an undergraduate materials course to use the fcility for an extrusion experiment is currently in the design and implementation phase.

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I Introduction

A 550 kip testing press was acquired by Texas A&M University during the period from April of 1998 through June of 1999. The primary function of the press is to aid in the equal channel angular extrusion (ECAE) process research currently underway in the Department of Mechanical Engineering. Secondary functions include material testing, education in material deformation, and fabrication forming. The acquisition of the press has enhanced the research efforts in ECAE processing by providing a dedicated, convenient, efficient, and safe facility for a wide range of related experiments. The research related educational benefits are being recognized via several graduate student research projects. A plan for an undergraduate materials course to use the facility for an extrusion experiment is currently in the design and implementation phase.

The location of the press is in room 104 of the Thompson Hall Building. A special operating environment is under construction to aid in the safe and efficient use of this instrument. Setting up the environment has included relocating associated materials and equipment, installation of needed plumbing and electrical connections, assembly of storage facilities for tooling and related equipment, and establishment of a workstation for the control system. Additional work on the environment remains to enclose for the hydraulic power supply in an acoustic chamber to reduce noise, and to enclose the press pinching workspace in a transparent isolation box to minimize accidents associated with normal press operation.

II Plan Schedule

The acquisition of the press required approximately 16 months, including the bidding process, manufacturing, and installation. The following timeline describes the chain of events leading to the now fully operational press.

April 30, 1998; Initial bids received from Instron and MTS Systems.

June 9, 1998; Revised bids received.

June 15, 1998; MTS System selected, paperwork handed over to Judy Welch in purchasing for ordering. Price, including rigging, acceleration compensated load cell, extra control cables, and a signal conditioner for one thermocouple was $385,925.

June 29, 1998; P. O. issued.

September 3, 1998; First payment voucher released. Work begins. TAMU was informed that the system was scheduled to be shipped 3/5/1999.

April 9, 1999; System delivered. The components were temporarily stored off campus due to site preparation activities.

April 14-18, 1999; Kirkland Crane arrived to rig and set the press in room 104 of the Thompson Hall Building.

April 28, 1999; Steve Groten of MTS arrives to set up the press. The process takes five days. The only signifigant problem encountered was an inadequate hydraulic oil reservoir. Also, a un-interruptable power supply was purchased, since there was a threat of catastrophic press action if the power were interrupted unexpectedly during normal press operations.

May 10, 1999; Turned off the computer for the first time and on restarting it, the computer failed to recognize the Workstation Communication Interface (WSCI) card. TAMU notified MTS Customer Service.

May 20, 1999; Steve Groten of MTS returns to repair the computer. He changed the DMA and IRQ settings from the default setting and it worked. A satisfactory explanation was never provided to explain what the actual problem was, but the fix is working. The system is now used on a regular basis.

May 24, 1999; A letter was written to Randy Strop of MTS outlining several problems: 1) inadequate reservoir capacity, 2)missing run time data plotter, 3)an unexplained computer failure, and 4)the deadline for final payment. Mr. Strop replied on the 28th stating that all issues would be resolved shortly.

June 25, 1999; Replacement reservoir arrived. Steve Groten arrived about two weeks later to install the reservoir replacement. The new reservoir holds 20 gal more than the original. Signed off on completion of installation.

August 4, 1999; Final payment issued.

III Press Description

The press installed is known by MTS Systems as a model 810 Custom system. The three main components of the system are the actual load frame, the hydraulic power supply (HPS), and the Test Star control system. The specifics of individual components are as follows:

The Load Frame:

The load frame is the business end of the system, actually applying the required force. It consist of a cross head mounted hydraulic cylinder, four accumulation cylinders, and a four post frame to react the forces. It is by far the largest component, weighing approximately 21,000 lbs, and standing 16' tall. The actuator is cross head mounted and has a 20 inch ram stroke. This piece differs from the original proposal which specified a base mounted actuator with an eight inch ram stroke. The decision for these changes were based on; 1) system overall performance, 2) press location and cost issues, 3) operational safety concerns, 4) installation issues, and 5) ease of maintenance. A photo of the load frame is shown in Figure 1.

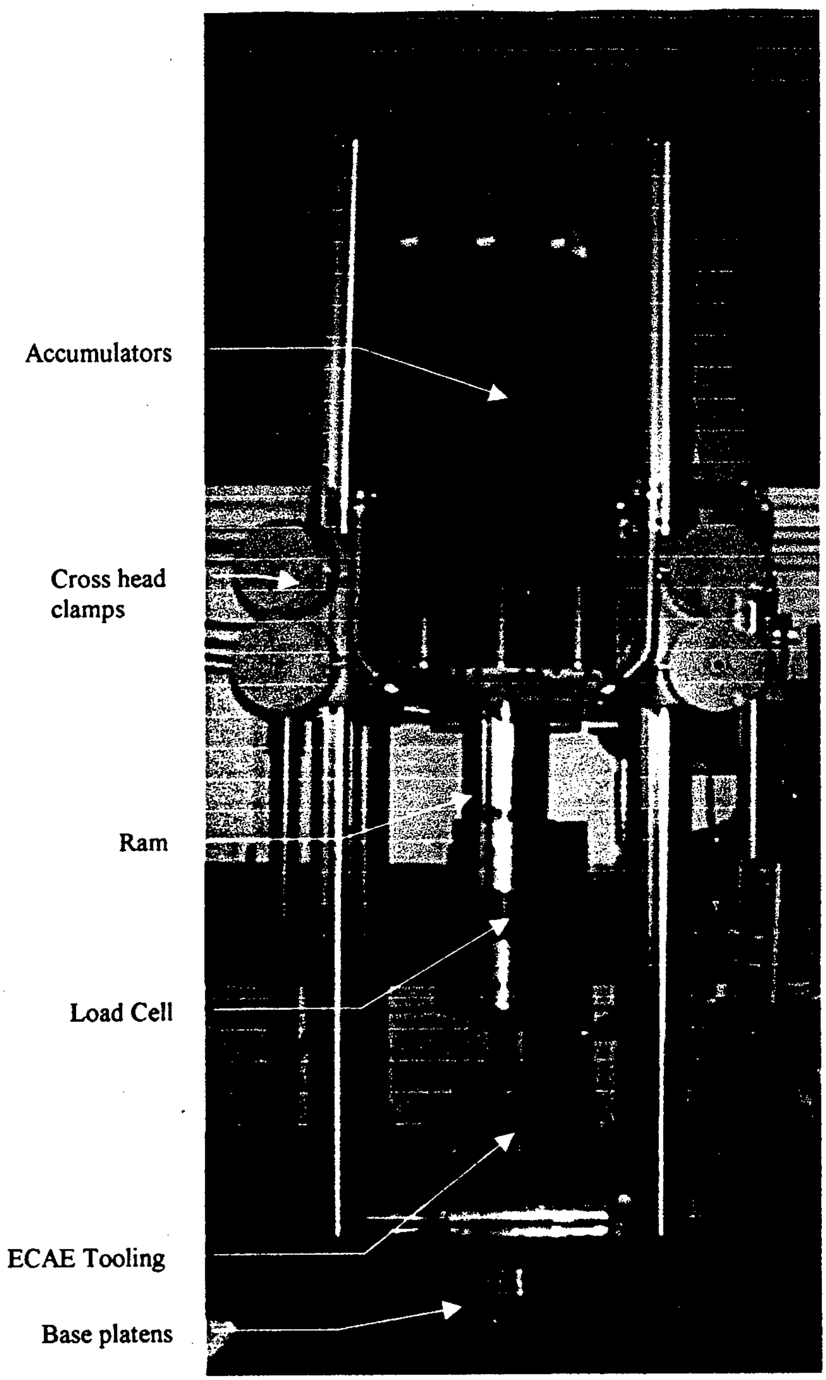


Figure 1: MTS System 810 Load Frame with 550,000 lb capacity

Specifications.

Cylinder (Cross head mounted):

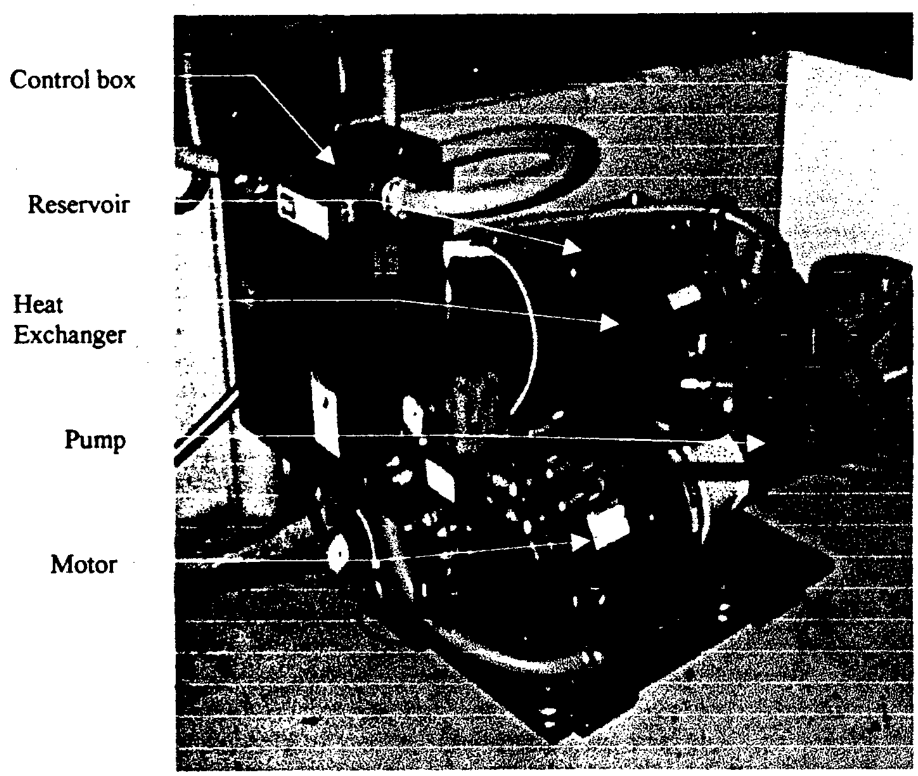
- Total Stroke..........................20 in.
- Cyl. Dia..............................20.6 in.
- Ram Dia.............................13.5 in.
- Effective Area............190.26 sq. In.
- Load capacity................570,800 lb (2446 kN)

Frame (Four post):

- Post Dia..................................6 in.
- Base platens width................44 in.
- Base platens depth................36 in.
- Actual workspace dimensions; 20 in. x 30 in. x 78 in.
- Hydraulically moved and locked cross head
- Three hydraulic accumulators for full force fast extrusions

Hydraulic Power Supply:

The HPS provides the hydraulic pressure required to operate the cylinder at the desired force. The proposal specified that the pump deliver 55 GPM so that the ram could move at a velocity of 1" per second or greater. It was determined that a smaller capacity pump combined with hydraulic accumulators would be a more cost effective way to configure the system. A minor limitation is a system cycle time of five minutes for full speed, full force, full stroke operation. It was found after setup and testing that the MTS stock model 510.10 HPS did not have sufficient reservoir capacity to operate the system as specified in the purchase order. This was rectified by MTS with a modified reservoir that holds an additional 20 gallons of hydraulic oil. Figure 2 shows the HPS.



Physical specifications:

- Height......................................40 in.
- Width.......................................34 in.
- Length.....................................50 in.
- Weight (dry).........................1300 lbs
- Reservoir capacity...............57.5 gal
- Flow rate...........................10.1 GPM
- Motor rating............................25 HP
- Requirements...3Φ, 460 VAC, 60 Hz

Figure 2: Hydraulic Power Supply Unit for 550,000 lb Press

Test Star Control System

The Test Star control system is the brains of the MTS system. It consist of the Test Star control chassis, a Compac 300 MHz computer with a "WSCI" interface card, and the "POD", or manual control interface. The Test Star chassis receives signals from the various transducers, LVDTs, and the computer, and generates the proper control signals that operate the numerous control valves and regulators on the Load Frame. The computer serves as the human interface with the Test Star control chassis, simplifying the control inputs. This differed from the proposal in that the system came with a Pentium 300 MHz processor rather than a 166 MHz processor. This is due to the rapid evolution of processors and the time required to manufacture the entire system. Through the computer, one can generate complicated routines that will record data, define the control parameters for the Load Frame, and define operator intervention events to help assure that safety protocols are observed. Also included with the system was a temperature reading chassis. There were two problems with the initial control system; the "WSCI" card in the computer failed to be recognized by the operating system, and on reading some of the initial operating procedures it was determined that the system could become dangerous if the power was abruptly turned off. To remedy this, a dedicated un-interruptable power source was purchased and installed for use with the press system. The control system is shown in Figure 3.

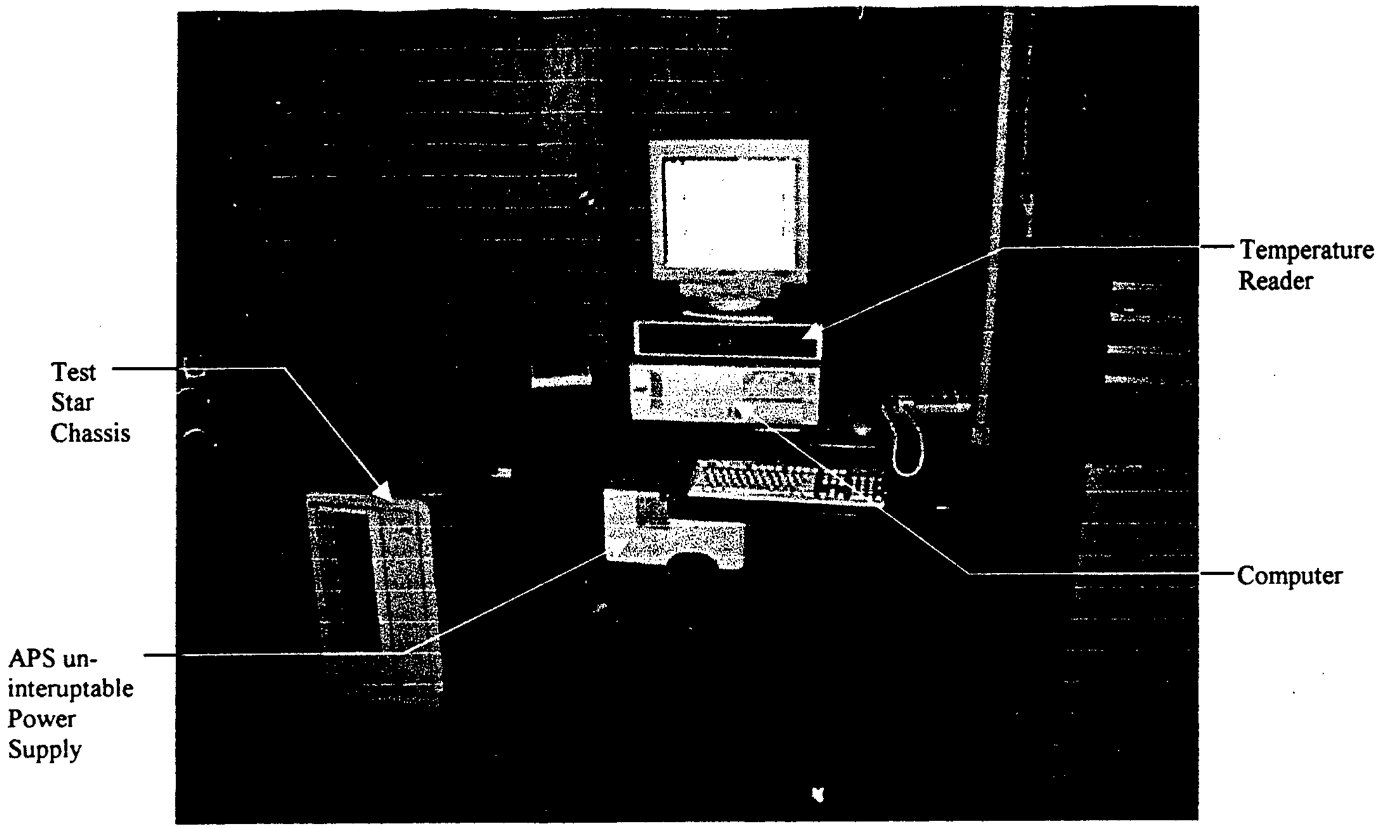


Figure 3: MTS System 810 Control System for ECAE press

Specifications

Compac Computer

Hardware

- Clock Speed..........................300 MHz
- CPU..............................Intel Pentium Celeron
- HDD..4 GB
- RAM..64 MB
- Built in;
  - Sound card.........................Deactivated
  - Ethernet Card.....................100/10
  - Case security system..........Locked
  - Video controller..................64 Bit
- 17" Trinitron Monitor
- WSCI Card (Workstation Controller Interface)

Software

- Operating System.................Windows NT
- MTS Software;
  - Test Star................Main Control Software
  - Testware...............Routine development and operating software
  - Run-time plotter.................Provides in-situ load/stroke information
  - Test Star Diagnostics.........Diagnostics software

Test Star Control System

Physical Specifications;

- Length...24 in.
- Width..14 in.
- Height...28 in.
- Weight..88 lbs

Technical Specifications;

- Instrumentation Channels.................16
- Control Channels.............................4
- Input Power....................110VAC @5A
- Output Power (PS)...................15VDC
- Resolution (I/O)...........................16 bit

Un-Interruptable Power Supply

- Manufactured by APS, Inc.
- 1000 watts un-interruptable power
- Provides 10 minutes of safe power.

The "POD", also known as the Load Unit Control Panel, or "LUC", is mounted on a stand near the load frame, allows manual operation of the ram (actuator) as well as remote program control. Other functions of the "POD" include; HPS control, Hydraulic Service Manifold (HSM) control, and some simple programming options. Immediately below the "POD" is the cross head control box. This unit allows manual positioning of the cross head as well as securing the cross head via the hydraulic clamps. A picture of the "POD" and the cross head control station is shown in Figure 4.

Emergency Stops

Display

Program Function Console

Program Control Console

HPS Console

HSM Console

Manual Controls

Cross head controls

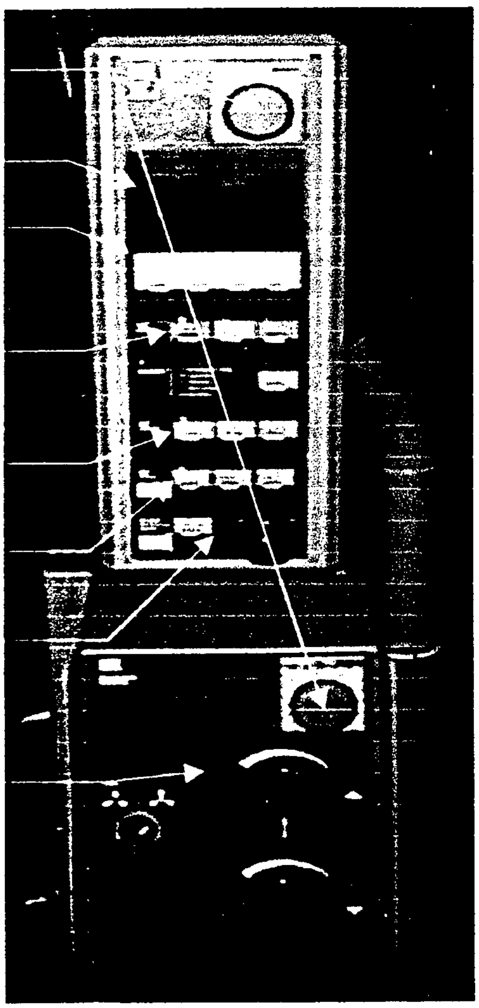


Figure 4; Photo of Load Unit Control Panel ("POD")

Specifications

POD;

- Height........................16 in.
- Width...........................6 in.
- Depth..........................3 in.
- Mounting.....Variable height and position 3 legged stand.
- Display........240 x 360 LED.

Cross Head Control Console;

- Height........................10 in.
- Width...........................8 in.
- Depth...........................7 in.

IV Research and Education Use

Research projects currently underway include the development of ECAE tooling for processing of cylindrical bars, ECAE processing of pure tantalum processing, ECAE processing of BiTe alloys for enhanced thermoelectric performance, recrystalization in heavily deformed pure copper, and ECAE processing of polymers for enhanced toughness. Two faculty, four graduate students and one research associate currently utilize the press facilities made available with DURIP funding.

The ECAE processing technique has been used at Texas A&M University over the last several years to impart dramatic changes in properties to a variety of materials. The process is simple in concept but can produce profound changes in the microstructure of bulk material which is not currently possible by conventional means. Extreme grain refinement, elimination of porosity, production of filamentary microstructures and the development of equiaxed and specially textured microstructures are examples of results possible via ECAE processing. Industry and U.S. Government Laboratories have shown and continue to show interest in the processing technique. With continued support from industry, the U.S. Government, Texas A&M University, and other sources the research and educational potential of the MTS system will be realized.